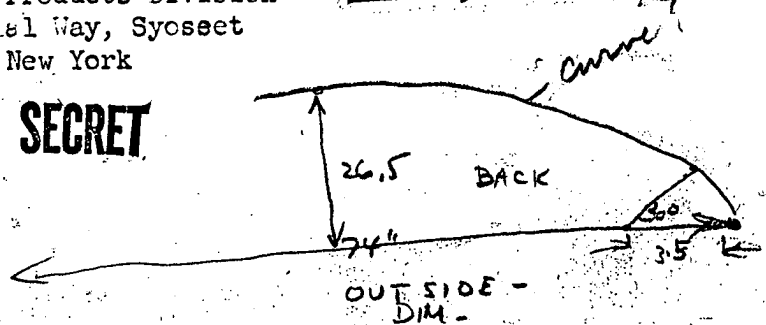


FAIRCHILD CAMERA AND INSTRUMENT CORPORATION
Defense Products Division
5 Aerial Way, Syosset
New York

GUS-V115
COPY 4 OF 5

SECRET



1hr 45min
film negd

HIGH ACUITY
RECONNAISSANCE



60" LENGTH

3" THICKNESS

Proposal No.
SME-CA-81

5.0.1213- proc. as direct positive - with fine
ASA 80 as opposed to direct neg. processing
with ASA-12- also positive gives much
greater tonal range - (Kodak process - 150K)
Can use 1/4000/sec exp. vs. 1/5000/sec/exp.

Camera - 1/1000 sec - max low contrast (2:1) 75 lines/mm
hi-contrast (1000:1) 120-150 lines/mm

Convergence - ?

SECRET

- 1 -

Copy 1 of 5
Destroyed by
19 Apr 78

Can # 2

25X1

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1 February 1959

INTRODUCTION

This proposal presents the preliminary design data for a photo reconnaissance system for a manned reconnaissance aircraft operating at 90,000 altitude and at MACH 4.0 velocity. The reconnaissance capacity used in the preliminary design data provides for a capability of approximately one and three quarters hours of photography of two types. (1) A primary or detail reconnaissance camera with paramount consideration for high information content and (2) a precision mapping camera with horizon to horizon coverage.

No attempt has been made at this time to determine a single type of camera or final configuration of a single type into the allowable space. Only continued liaison with the airframe manufacturer can make such selection meaningful.

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ANALYSIS OF GENERAL DESIGN FACTORS

After preliminary consideration of the vehicle operating range and mission requirements it has become more and more evident that the design parameters of the primary reconnaissance camera are covered best by the panoramic camera installation. From the standpoint of angular coverage and the requirements of focal length the frame type camera installation would require a multiple camera installation which would be intolerable in space, weight and cost.

In the past, panoramic photography has been considered impractical for most installation because of their size. Through the use of modern techniques this is no longer the case as will be indicated in the succeeding section of this proposal.

In the preliminary system analysis made herein the following ground rules have been used as limits.

1. Maximum Information Content
2. Altitude of vehicle - 90,000 feet.
3. Velocity of vehicle MACH 4(3884 feet/second).
4. Sixty percent overlap of photography.
5. Lateral angular coverage - 90°.
6. Time of photography 1-3/4 hours (6340 seconds).
7. Space configuration as shown in the various figures.

In addition to the above it has been required to provide an "Index Mapping Camera" capability with the following requirements:

1. Maximum Information Content.
2. Altitude of vehicle - 90,000 feet.
3. Velocity of vehicle MACH 4(3884 feet/second).
4. Sixty percent overlap.
5. Lateral angular coverage 180°.
6. Time of photography 1-3/4 hours (6340 seconds).
7. Minimum photogrammetric distortion.
8. Maximum photographic quality.

In the following pages brief descriptions are given of the various camera installations which fulfill the primary mission requirements. It should be understood that in all cases the layouts are of a preliminary nature and can to a large extent be revised to suit specific requirements of the airframe manufacturer.

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TYPES OF PANORAMIC CAMERAS

The Basic Rotary Panoramic Camera

The rotary panoramic camera utilizes the principle of rotating a mirror inclined at an angle of 45° with respect to the axis of rotation. The entire camera including the film magazine rotates about this single axis continuously. A typical configuration drawing is shown in figure 1. It can be seen from this figure that this type of camera is desirable when the allocated space resembles that of a pod or missile type installation.

The principle of operation consists of imaging the target area on a focal plane slit and intermittently driving the film past this slit in synchronism with the angular rotation of the camera. Therefore, any desired angle of coverage can be accomplished by properly phasing the film drive engagement and dis-engagement to "paint" on the appropriate portion of the target area. During the remainder of each rotation or several rotations as the case may be, the film is stationary and only a thin overexposed strip results between photographic frames.

The advantage of this type camera, besides its unique space configuration, is that it can cover any angle of scan desirable by the simple programming of the film metering drive system. Since the entire camera rotates, representing a relatively large inertia, the rotational speed can be made quite smooth and accurate, thereby permitting a precision velocity command to the film metering drive system. Also, the power consumption for this type of camera is relatively low because of the constant speed drive of the majority of the camera mass.

This type of camera has been developed by Fairchild and it has proven to be a basically sound, reliable piece of equipment for photographic reconnaissance. Techniques have been proven which permits reliable film handling in spite of the fact that intermittent film motion demands slack loop control to avoid acceleration and deceleration of the film spools. The constantly rotating spools are mandatory in a high acuity rotating panoramic camera to avoid dynamic reaction that would degrade the photographic image. By using slack loops, the masses to be accelerated and decelerated are minor and do not contribute to any degradation of resolution.

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These slack loops also permit image motion compensation by rotating the film and focal plane assembly thru the desired sinusoidal motion while the film is moving by focal plane slit. This motion results in generating the forward motion vector velocity of the film in exact phase with the V/H value at any instant of scan.

Fairchild Chimney Type Panoramic Camera

The chimney type panoramic camera utilizes the old optical principle of rotating a lens about its nodal point while scanning a target and "painting" the image on a focal plane arc that contains the fresh unexposed film. The designation of chimney originated from the fact that the lens cone up to the focal plane slit which rotates with the lens assembly resembles a chimney in appearance. A configuration of this type of camera is shown in figure 2. Because of the space allotment, the camera orientation requires a fixed 45° mirror mounted in front of the pivoting lens assembly.

The principles of operation of the chimney type panoramic camera takes advantage of the fact that no image motion exists at the focal plane when a lens is rotated about its nodal point, hence, the film remains stationary in the focal plane arc during the photographic scan, resulting in the important advantage of no synchronization being necessary. The accuracy and smoothness of the lens drive system is not critical since no resolution degradation results from a relatively crude drive. However, a smooth drive is desirable from the standpoint of maintaining proper exposure and to avoid possible banding.

As with all panoramic cameras, the slit width determines the exposure time and in this case the slit width in conjunction with the lens angular velocity produces the overall exposure time.

Film handling is accomplished by intermittent metering of fresh film into the focal plane arc during either the capped return stroke of the lens drive or during the portion of the cycle that the lens is outside the format. Loop control is also utilized to permit continuous rotating of the relatively large spools of film.

Image motion compensation can be achieved readily on this type of camera by providing a fixed cam near the axis of rotation of the lens and allowing the lens to move along its axis of rotation while scanning to provide the necessary cosine function for proper DMC.

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Fairchild has developed a chimney type panoramic camera which has proven to be extremely reliable in addition to having inherent high performance in terms of resolution.

Traveling Lens Panoramic Camera

The traveling lens panoramic camera utilizes the principle of moving a lens and slit assembly along a stationary film format plane while simultaneously picking up or scanning the ground or target area with a rotating prism or mirror assembly. A basic configuration showing this type of panoramic camera utilizing a rotating prism is shown in figure 3. The fundamental requirement of this type of camera is to properly synchronize the prism rotation and the linear scan motion of the lens-prism assembly. This synchronization is accomplished by precision mechanism tie-in between the linear and rotational motions and offers the advantage of stationary film during exposure. As long as the tie-in of the prism rotation to the linear motion is precise, the accuracy of the linear drive is not critical. Because of the stationary film, this type of panoramic camera offers similar advantages provided by the chimney type camera.

The prism is used with the traveling lens panoramic camera when the large angles of coverage are desired, such as horizon to horizon capability. A rotating mirror may be substituted for the prism, as shown in figure 4, for smaller coverage angles. As shown in figures 4, 6, and 7 this technique is feasible by providing a dual camera installation. Additional advantages of the dual camera installation may be realized from the standpoint of reliability and reduction in film spool sizes. The advantage of using the mirror where applicable is that the prism has limited resolution capabilities and is also considerably more expensive and heavier for a given system.

Shown in figure 4 is a 24" Baker lens designed specifically for a panoramic camera fabricated by Fairchild. The anticipated resolution for this lens in the configuration shown is well above 50 lines/mm AWAR on Plus X film and above 100 lines/mm AWAR on a film such as S01213.

Film handling is accomplished in this type of camera by conventional means since it consists of a flat focal plane with the film stationary during exposure. Image motion compensation can be achieved on this type of camera by moving the lens prism assembly or lens mirror assembly, as the case may be, laterally during its scan. Figure 5 shows an attempt to use the traveling lens and mirror approach with the Baker High Acuity

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lens which exhibits still higher resolution. It is obvious from the preliminary sketch that this lens could not be utilized in the estimated space allotted in conjunction with the traveling lens application, however, coordination with the airframe manufacturer may open up a new approach providing a satisfactory solution. Fairchild has developed a traveling lens and prism panoramic camera known as the Index Camera which proved to be a sound and practical design approach. This camera resulted in high resolution capacity in conjunction with a simple and reliable design.

Rotating Prism Panoramic Camera

The rotating prism panoramic camera is basically similar to the traveling lens prism camera except that the lens and prism do not move linearly but instead the film is driven past a focal plane slit. This camera requires the synchronization between the rotating prism and the moving film during scan and in this respect is somewhat related to the Rotary Panoramic Camera. However, the space configuration is considerably different and hence has application by virtue of its unique shape. Although no figure is provided in this proposal, the configuration can be visualized as a tall, slender arrangement with prism, lens, focal plane, and magazine all built up on top of each other.

As with the traveling lens panoramic, the prism can be replaced by a mirror for a limited angle of coverage. Two (2) such configurations are shown in figures 6 and 7. Since the lens is stationary in this type of panoramic camera the optical path can be folded for convenience as shown in figure 6, or the lens-film optical path can be simple as shown in figure 7. The nodding mirror arrangement is somewhat different from the rotating prism in that the nodding mirror is bi-directional with the film stationary during the mirror return stroke. Again only the slit area becomes over exposed between format frames.

Slack loops are used in both configurations of the nodding mirror approach to permit intermittent, relatively high speed scanning past a fixed slit. Again this type of camera image motion compensation may be accomplished by rocking the focal plane slit and film through the proper function during scan.

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FILM FOOTAGE CONSIDERATIONS

During the initial system analysis for this photographic installation a review was made to give insight to the film footage requirements.

The requirements for film footage may be analysed as follows for a panoramic camera:

Footage = Cycling rate of camera x time of photography x length of each exposure.

For this vehicle the following expression may be derived:

$$\text{Film Footage} = \frac{V \times f^2 \times T \times \theta}{HK (L) (\%) } \quad (1)$$

where

- V = 3880 feet/second
- H = 90,000 feet
- L = film format in flight direction (inches)
- % = 1-% overlap (1-60% = 0.40)
- T = 6340 (seconds)
- f = focal length (inches)
- θ = lateral scan angle (radians)
- K = Conversion factor (inches/foot)

resulting in:

$$\text{Film Footage} = 89.5 \frac{f^2}{L} \quad (\text{Slide Rule}) \quad (2)$$

As can be noted the focal length is a very significant factor in film footage requirement. The following table indicates the range of footage as a function of focal length and film width for the condition of V = 3884, H = 90,000; T = 6340, $\theta = 90^\circ$.

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<u>Focal Length</u>	<u>Film Size</u>	<u>Format Size (L)</u>	<u>Film Footage</u>	<u>Minimum Spool Diameter</u>
48"	9-1/2"	9"	22,900'	38"
	5"	4-1/2	45,800'	54"
	70mm	2-1/4	91,800'	75"
36"	9-1/2"	9"	12,850'	29"
	5"	4-1/2	25,700'	42"
	70mm	2-1/4	51,500'	61"
24"	9-1/2"	9"	5,720'	20"
	5"	4-1/2	11,400'	27"
	70mm	2-1/4	22,800'	38"
12"	9-1/2"	9"	1,430'	9.5"
	5"	4-1/2	2,860'	13.5"
	70mm	2-1/4	5,720'	19.0"

As indicated in the table some of these combinations are out of the question because of space available (48" focal length - 70mm film resulting in a spool diameter of 75"). Others such as those above approximately 10-15,000 feet of film should be placed in an improbable category because of film spooling and handling characteristics. It should be noted that some relief on space, film spooling and film handling problems may be obtained by dual camera installations.

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RESOLUTION AND EXPOSURE CONSIDERATIONS

The resolution requirements and exposure necessary in a reconnaissance camera are closely allied functions. Invariably, the parameters selected must be a compromise to give the best overall system efficiency rather than being able to choose the optimum condition for each requirement. Since image motion exists due to vehicle motion and scanning operations and compensation for all these undesirable motions is complex, relatively short exposure times are necessary to limit the smear or blurring of the image during exposure.

With given light conditions of aerial photography, a relatively short exposure time demands a large aperture lens and/or high speed film emulsions. Unfortunately, both large aperture lens and high speed film emulsion parameters lead in a direction of reduced resolution capability. In the case of this program it has been tentatively concluded that the delivery time for the system prohibits new developments in lenses and film emulsions, it is necessary to select the best known components available to arrive at the best overall results.

Exposure Factors

In determining the required exposures for the detail reconnaissance camera, several factors must be taken into consideration. Among the most important are scene brightness and brightness ratio at the camera, spectral distribution of image forming light, film speed, film spectral sensitivity, film quality capability, shutter speed, aperture, film processing, time of day, month and cloud cover.

For convenience, each major factor can be considered separately prior to the discussion of the interdependence of these factors.

a. Brightness

Scene brightness on the ground is calculated from standard equations and from experimental data. * Scene brightness includes both direct illumination and sky light in the horizontal plane. Based on the best data available assumed

-
- * 1) Smithsonian Physical Tables, 9th Revised Edition and
 - 2) Smithsonian Meteorological Tables, 6th Revised Edition.

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average values of 0.1 for atmospheric reflectivity (no cloud cover), 0.9 for atmospheric transmissivity and 0.2 for ground reflectivity can be used to complete the calculation of scene brightness of a ground target from above the atmosphere observed. Figure 8 presents this data plotted as a function of solar altitude.

b. Scene Brightness Ratio

As we consider decreasing solar altitudes, an increasing percentage of the light reaching the camera is from atmospheric reflection. This adds an increasing uniform illumination to the ground target light thus lowering the apparent target brightness ratio. The decrease in target contrast with increasing percentage of sky light (decreasing solar altitude) can be determined where target contrast may be plotted as a function of solar altitude.

c. Spectral Distribution of Image Forming Light

At very low and decreasing solar altitudes the spectrum of the direct illumination shifts rapidly towards the red while sky light is still predominately in the blue region. These factors allow the choice of several techniques for obtaining photographic information at low solar altitudes if such becomes an operation requirement.

d. Film Characteristics

1. Spectral Sensitivities

All films that can be favorably considered for use in the proposed cameras on the basis of speed, quality, and availability have completely adequate spectral sensitivity characteristics.

Quality and Speed

At any given time in the state-of-the-art of silver halide sensitization, image quality capability varies as some inverse function of film speed. This fact immediately presents a balance between film quality and speed that must be made in the choice of a suitable emulsion since it is necessary to obtain both high quality images and the longest possible operational day.

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Computation of System Quality as a Function of Length of Operational Day

a. Scene Brightness at Various Locations and Times

For a given day, time and geographical location, film exposing brightness is computed using equation (3) below to determine solar altitude and Figure 8 to determine scene brightness at this solar Altitude.

$$\sin \alpha = \sin \lambda \cdot \sin \delta + \cos \lambda \cdot \cos \delta \cdot \cos 15t \quad (3)$$

where: α is the solar altitude in degrees.
 λ is the latitude (North).
 t is the time in hours from noon. (local).
 δ is the declination where $\sin \delta = \sin T \sin 23.5^\circ$.
 T is in days with March 21 = 0.

Such considerations can be made for any given set of operational latitudes for a given mission at any date of the year.

b. Brightness required for Given Exposure Time and Lens-Film Combination

Calculation of scene brightness required for a given exposure time can be made utilizing equation (4).

$$B = \frac{K \cdot C \cdot T^2}{t \cdot S} \quad (4)$$

where: B = Scene Brightness (foot-lamberts)
 K = Constant defining working density on film negative (0.5)
 C = Filter factor (transmission reduction) (2.0)
 t = Effective exposure time (sec.)
 S = Emulsion sensitivity rating
 T = T Stop number

In all calculations, film speed criteria should be chosen so as to place the various scene brightnesses on the film in a manner that will allow maximum utilization of inherent film resolution (which is a function of exposure and film processing) and that will result in a minimum of 1 stop exposure latitude for the given scene brightness ratio.

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c. Resolution Degradation Resulting from Image Motion

Experimental work in connection with varying amounts of relative motion (motion between film and image) have been performed (Romer¹ and Gregory²) showing the degradation in resolution with motion.

These experiments were carried out with actual lens-film-camera combinations and with precisely controlled motion being introduced to observe the degradation. These data are plotted in figure 9. This type of data is applicable to the system analysis of the proposed system.

Frequency Distribution of Dynamic System Resolution

Several studies have attempted to arrive at a system of evaluation of a photographic reconnaissance system. None having been successful it remains that evaluation at this time are generally thought of in terms of resolution in lines per millimeter. Fairchild has approached the evaluation of a proposed system in terms of "Dynamic System Resolution." In doing so all of the known degradation factors are considered and their effect on the final resolution is predicted. To prevent misinterpretation of the results of such a method of analysis it is important to note that the value reported is the resultant resolution under extreme conditions. By observing past results of experimentation such as performed by Boston University Optical Research Labs it will be apparent that these conditions exist on a small percentage of the time.

At such time as the values of vehicle or camera stability, FMC error, vibrations etc. are known with some degree of certainty the complete analysis can be made.

Supersonic Considerations

It should be pointed out that a photographic reconnaissance system from a supersonic vehicle must consider the effects of shock wave and boundary layer on both photographic quality and photogrammetric quality. The consideration is divided into these two categories mainly because of the two types of cameras aboard the aircraft.

In general past experimentation has shown very small effects on photographic quality and therefore should not be of great concern in the proposed mission. The photogrammetric effect is still under evaluation and no specific data is available at this time.

*1) "Suppression of Image Movement in Air Photography" W. Romer, D. Techn. Sc., Poland, F. Inst.P., F.R.P.S. Royal Aircraft Establishment, Farnborough, Hants, England.

2) "Interim Reports on the Effect of Image Movement on the Definition of Air Photographs" - J.M. Gregory, Kodak Research Labs; Harrow, England, AT1165074, F52-2-1947 Reel C-6723.

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STABILITY REQUIREMENTS

The photographic quality of any reconnaissance system relies to some extent on the stability of vehicle. To design against the worst wind gust that may be imparted to the vehicle and still obtain high acuity photographic results would unduely penalize the entire system. In some installations the stabilization of the photographic sensor can be obtained by a special camera mount. The steadiness capability of this mount then need only be considered in determining the degradation of the photographic image from blur.

As indicated in the previous section experimental work has been made in connection with varying amounts of motion. (See figure 9). As can be seen the small increment of residual motion introduced into the high acuity system has a very significant effect as compared to the same motion on low resolution system.

For the proposed configuration it may be well for consideration of stability to be made at this time to keep in the foreground of planning the order of magnitude of stability required.

To arrive at such a value it is necessary to assume some reasonable values of shutter speeds to be used in the final installation. For a preliminary estimate this is taken as 1/500 second. Figure 10 is a plot of the resulting relative motion for two focal lengths as a function of the stability requirements of the vehicle assuming no stabilized mount. It is very important to note that in working with such a plot in connection with degradation of resolution (figure 9) the stability of the vehicle only is considered. Other factors such as degradation as a function of IMC error, vibration, aperture, etc. must also be considered. It is considered inappropriate to carry on further exact calculations of the stability requirements at this time. Suffice it to say the camera stability should be held to a fraction of a degree per second in roll and pitch.

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MAPPING CAMERA REQUIREMENTS

The requirements for a mapping capability from the design altitude of this vehicle are severe when compared to normal mapping technique. As such, it is believed that a specific effort should be made to produce photographs which are at the practical limit in the state-of-the-art of mapping cameras and lenses.

The horizon to horizon requirement exists for the mapping capability and therefore presents some limitation of the type of equipment which can be expected to do the job. With such a requirement imposed one is faced immediately with special consideration of the photographic window in the vehicle. Some versions of the panoramic camera presents no insurmountable problems with respect to data reduction in terms of mapping. However the installation of a panoramic camera in a "flat bottom" vehicle such as anticipated here causes serious reservations on the feasibility of a satisfactory solution of the window problem.

In the case of a rotating prism type camera to perform the horizon to horizon scan the installation requires a "small" bubble be inserted into the slip stream of the vehicle which is considered unsatisfactory.

If a solution to this particular aspect of the window problem can be obtained there remains a second serious consideration of stabilization to a vertical. Any attempts to stabilize a rotating prism panoramic must consider the distortions introduced by misalignment of the center of prism rotation with the geometrical center of the bubble. Additionally there remains in this type panoramic camera the problem of photogrammetric measurements to be made when utilizing a camera whose film is "theoretically" synchronized with the prism rotation.

In the case of a "chimney" type panoramic experience has shown that the maximum practical angle of scan is 120°-far from the horizon to horizon coverage required. Again the window problem is a serious consideration for even the 120° scan angle.

Fairchild has made a preliminary design of a 3" f3.5 lens ultraprecision mapping camera which will allow an installation to be made as the well known "TRI-MET" installation, i.e., one vertical camera and two cameras at 60° off the vertical, thus reducing to an absolute minimum the problem of the window in this type vehicle.

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This camera is shown in figure 11 with pertinent dimensions and the basic Tri-Met relationship.

The camera will be a pulse mode operated ultraprecision mapping camera with a wide angle Baker 3" f3.5 "distortionless" lens covering a format of 4-1/2 x 4-1/2".

The camera will be designed to provide the following:

1. Inner cone construction which brings into a single assembly the principle factors which control the accuracy of the photogrammetric factors - lens, focal plane, shutter, fiducial markers.
2. The lens will contain as part of its optical elements a plate, the top surface of which will be the focal plane of the lens. A precision machined pressure plate having a flatness tolerance within 0.0002" will be provided to sandwich the film against the lens plate during exposure. Therefore vacuum for flattening the film need not be provided. The lens resolution will be above 60 lines/mm, AWAR on Plus X film. Distortion error will be less than five microns in the major portion of the field and not more than ten microns throughout the field. A Minus Blue filter will be provided with the lens.
3. The Rapidyne Shutter, representing the most advanced design in high efficiency high speed between-the-lens shutters will be utilized. This basic shutter has been a standard part of the T-11 and KC-1 cameras and has a proven reliability record well in excess of 20,000 cycles. The shutter will be tripped by means of an electronic timer and will have continuously variable shutter speeds from 1/50 to 1/700 of a second total open time.
4. The magazine will be designed to accommodate 200 feet of thin base aerial film 5" wide.
5. Provision can be made for either digital binary recording of pertinent flight data, or the recording of data instruments through a system of internal lighting and recording lenses. Fiducial markers accurately locating the principle point of the lens will be recorded with both artificial and natural light.

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The estimated camera weight will be 30 lbs. of which the lens will be approximately 8 lbs.

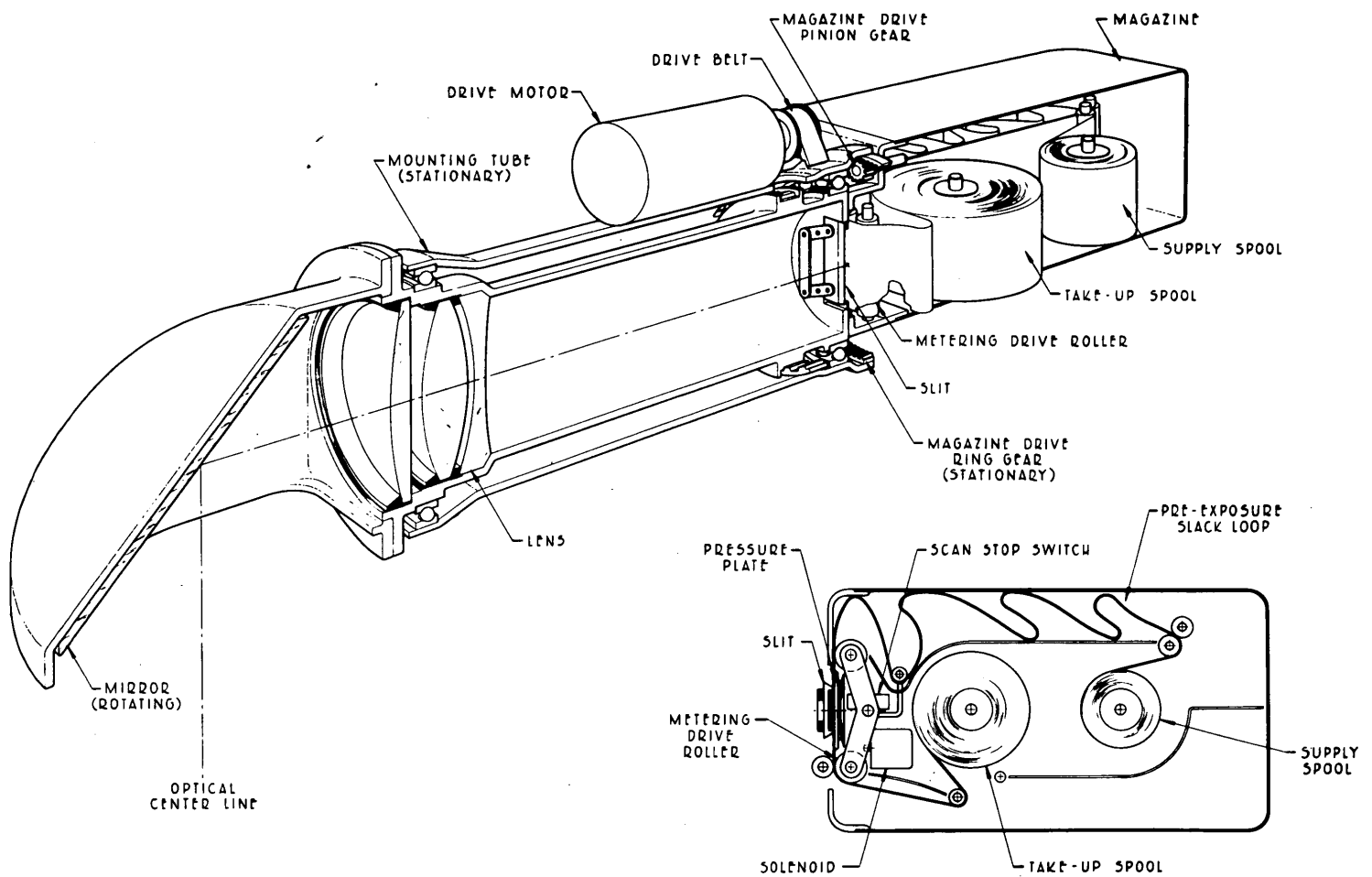
The proposed camera indicated in figure 11 is also shown in the installation drawings of the various types of panoramic cameras.

Ground Intelligence Support Equipment

The valuable information contained in the latent image of the film can only be after proper processing on the ground. In the case of both camera types - primary reconnaissance camera and precision mapping camera-utmost care must be exercised to prevent loss of the high information content. This can be done using modern processing machines and techniques.

The extraction of information from the processed material requires modern techniques in terms of photographic interpretation and photogrammetric analysis.

Depending upon the schedules of flights to be made the equipments and techniques well known today will be adequate. If a particularly heavy flight schedule is anticipated in terms of flights per month other proven techniques can be utilized to give the proper scheduling to provide interpretation and photogrammetric analysis. The later is particularly adaptable to high speed electronic computers after initial programming for the target location function. Continuous plotting of planimetric detail and to some extent topography be done by conventional high accuracy plotters to produce acceptable maps.



BASIC ROTARY PANORAMIC CAMERA

FIGURE 1

MAGAZINE SCHEMATIC

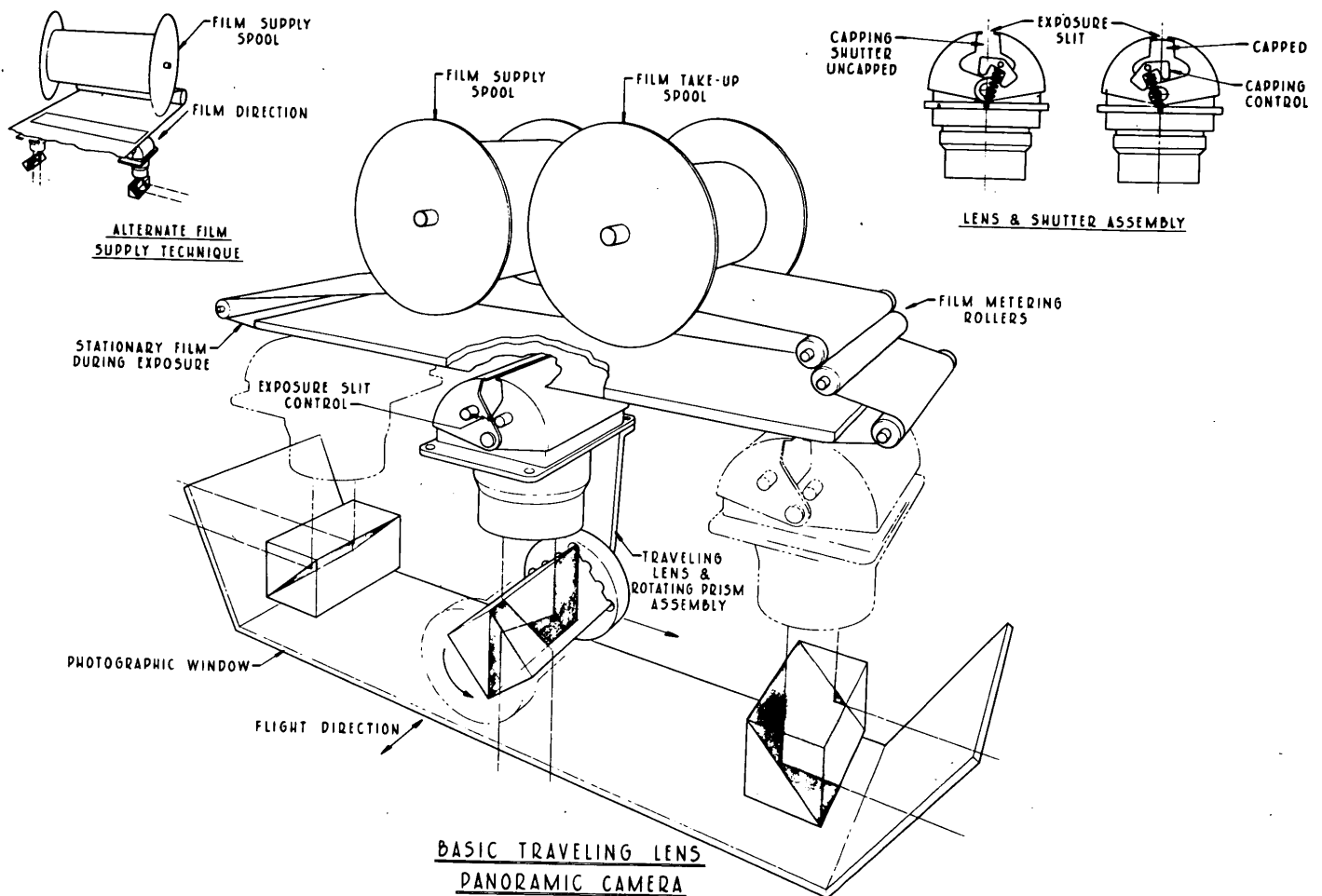
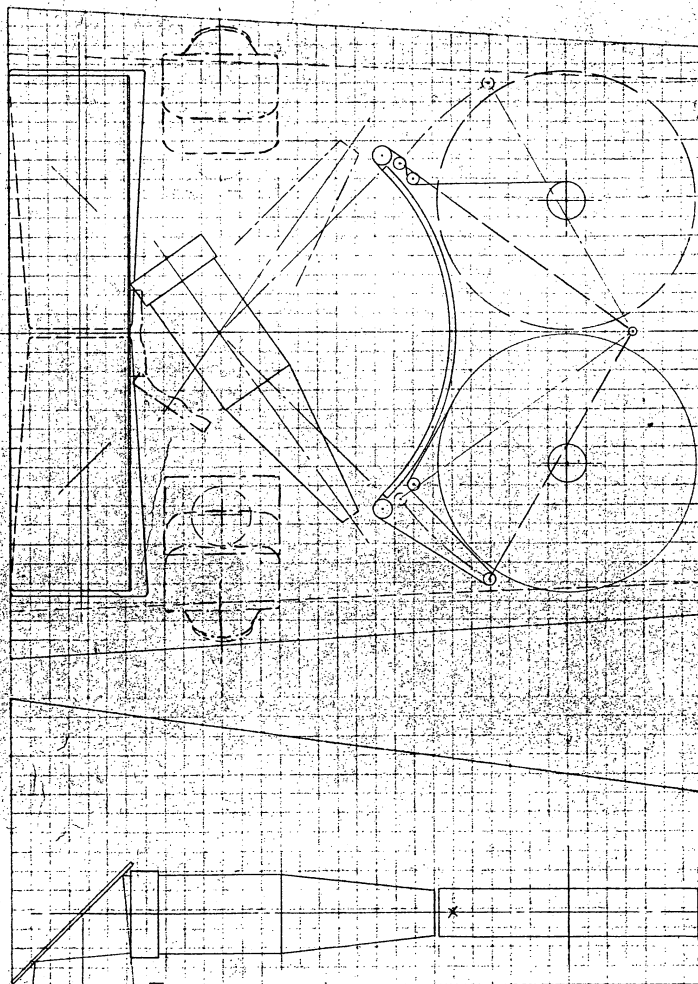


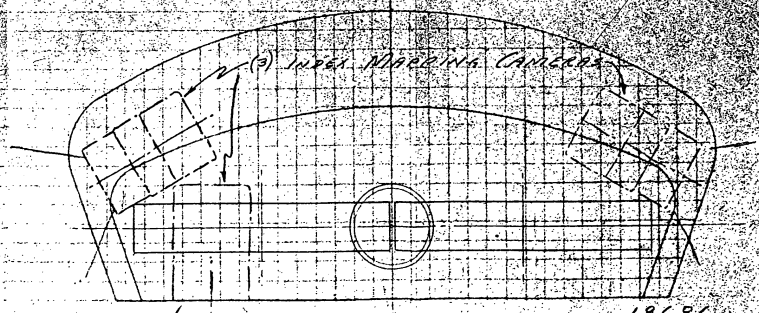
FIGURE 3



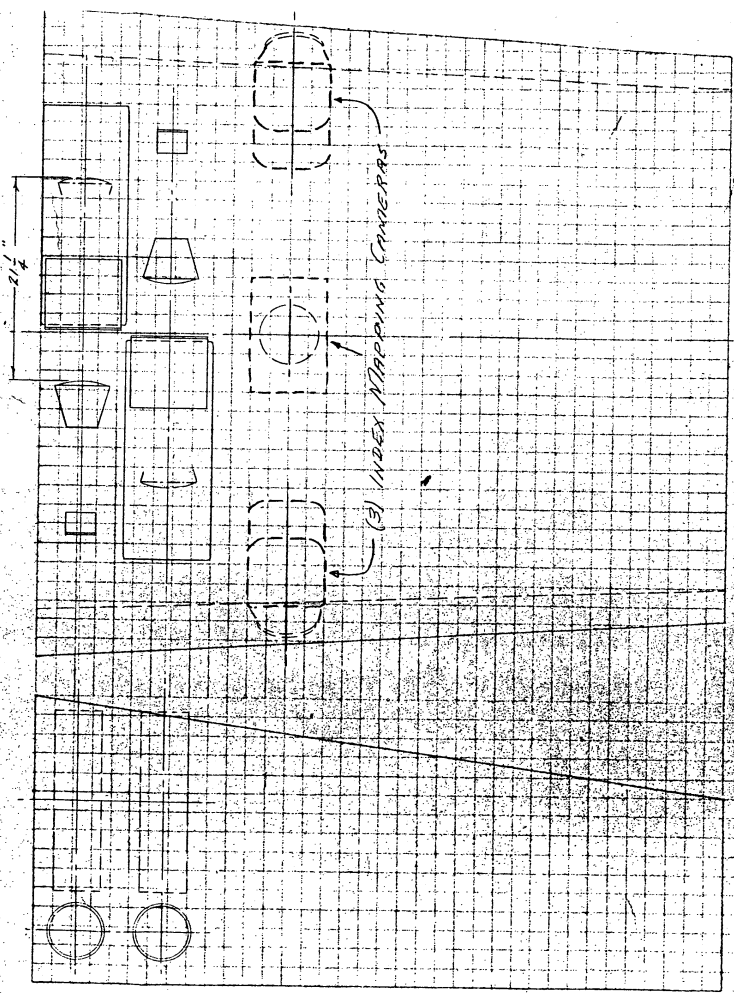
NAME - CHIMNEY (FOLDED)
 SCALE - 1" = 10" DATE - 1-16-59 DWN. G.L.
 FILM WIDTH - 5" FORMAT - 4 1/2" x 37 3/4"
 FOCAL LENGTH - 24 1/4"
 FILM/CAMERA - 11350 SPool DIA. 27"
 WGT. OPTICS - 75
 WGT. FILM -
 WGT. MECHANISM -
 WGT. MOUNT -
 TOTAL EST. WGT./CAMERA -
 EST. WGT. CAMERA SYSTEM -
 WINDOW SIZE - 55" x 14 1/2"

FILM/SCAN - 37.7"
 NO SCANS - 3610
 CYCLE TIME - 1.75 SEC.
 SCAN TIME - 5.85 SEC.
 FILM FEED - 21.6" / SEC.
 SCAN "W" - 9.68 / SEC.

FIG. 2



9053-31-1
51 1004



NAME: TRAVELING LENS & HALF SPEED MIRROR
 SCALE: 1" = 10" DATE: 1-17-59 DWN: GLL
 FILM WIDTH: 5" FORMAT: 4 1/2" x 19"
 FOCAL LENGTH: 24" ± 5
 FILM/CAMERA: 5675' SPOOL DIA: 19 1/4"
 WGT. OPTICS:
 WGT. FILM:
 WGT. MECHANISM:
 WGT. MOUNT:
 TOTAL EST. WGT./CAMERA:
 EST. WGT. CAMERA SYSTEM:
 WINDOW SIZE: 9" x 23" (2)

60-7000

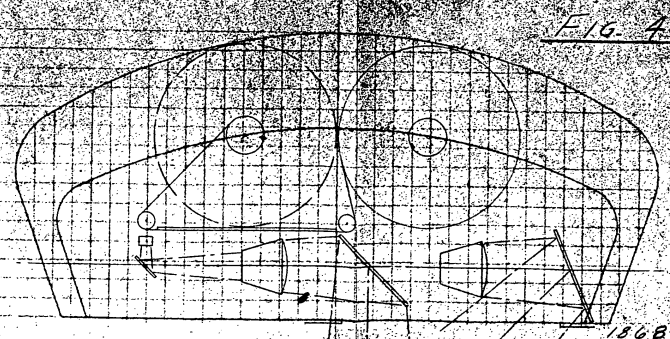
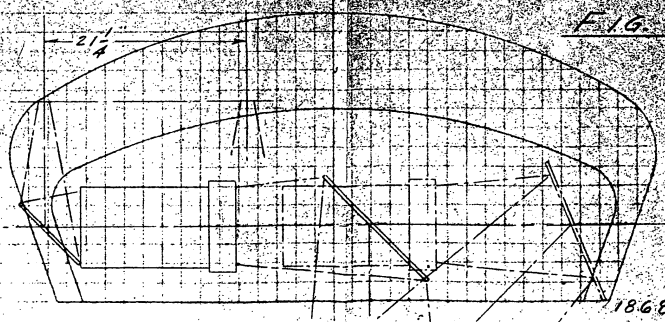


FIG. 4

18687

NAME - TRAVELING LENS & MIRRORS
 SCALE: 1" = 10" DATE: 1-16-59 DWN: G.L.
 FILM WIDTH: 5" FORMAT: 4" x 19"
 FOCAL LENGTH: 24" 4
 FILM / CAMERA: SPOOL DIA:
 WGT. OPTICS:
 WGT. FILM:
 WGT. MECHANISM:
 WGT. MOUNT:
 TOTAL EST. WGT. / CAMERA:
 EST. WGT. CAMERA SYSTEM:
 WINDOW SIZE:

VIEW SHOWS THAT THIS LENS DOES
 NOT FIT IN THE ASSUMED SPACE



NAME: NODDING MIRROR

SCALE: 1" = 10"

DATE: 1-17-59 DWN: G.L.

FILM WIDTH: 5" FORMAT: 4 1/2" x 19"

FOCAL LENGTH: 24 f5

FILM/CAMERA: 5675 SPOOL DIA: 19 1/4

WGT. OPTICS:

WGT. FILM:

WGT. MECHANISM:

WGT. MOUNT:

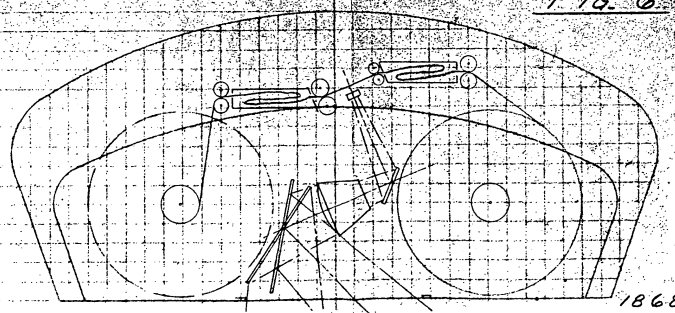
TOTAL EST. WGT./CAMERA:

EST. WGT. CAMERA SYSTEM:

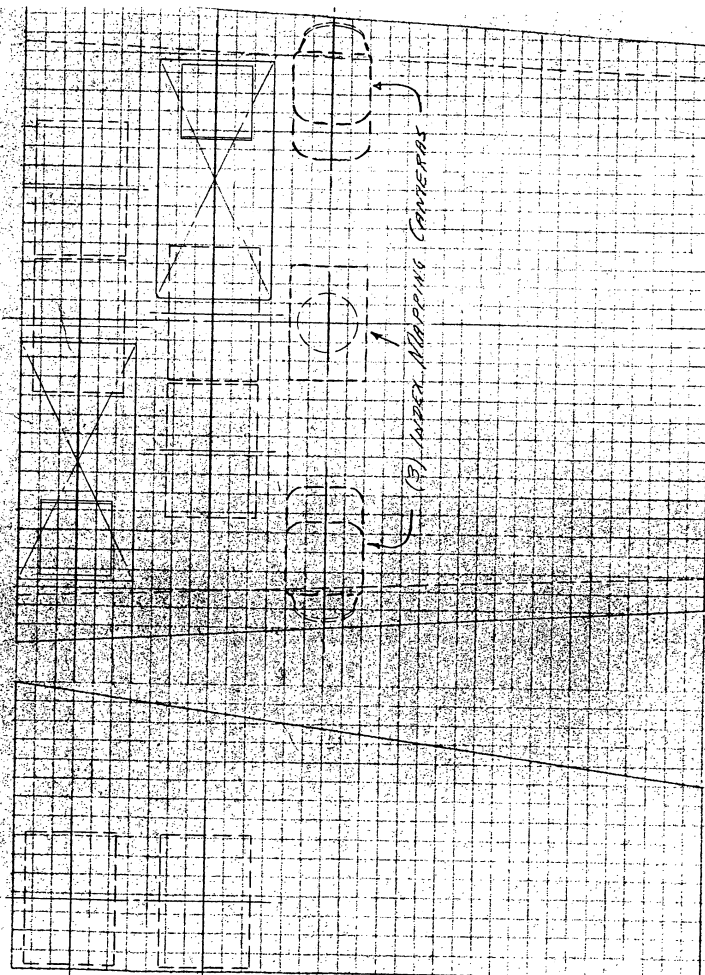
WINDOW SIZE: 10" x 8 1/2" (12)

Dynamic Res.
50-60 f/min (H.C.)
15% - 20% Error LC

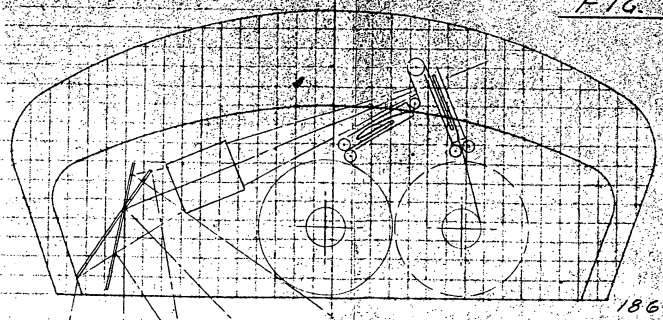
FIG. 6

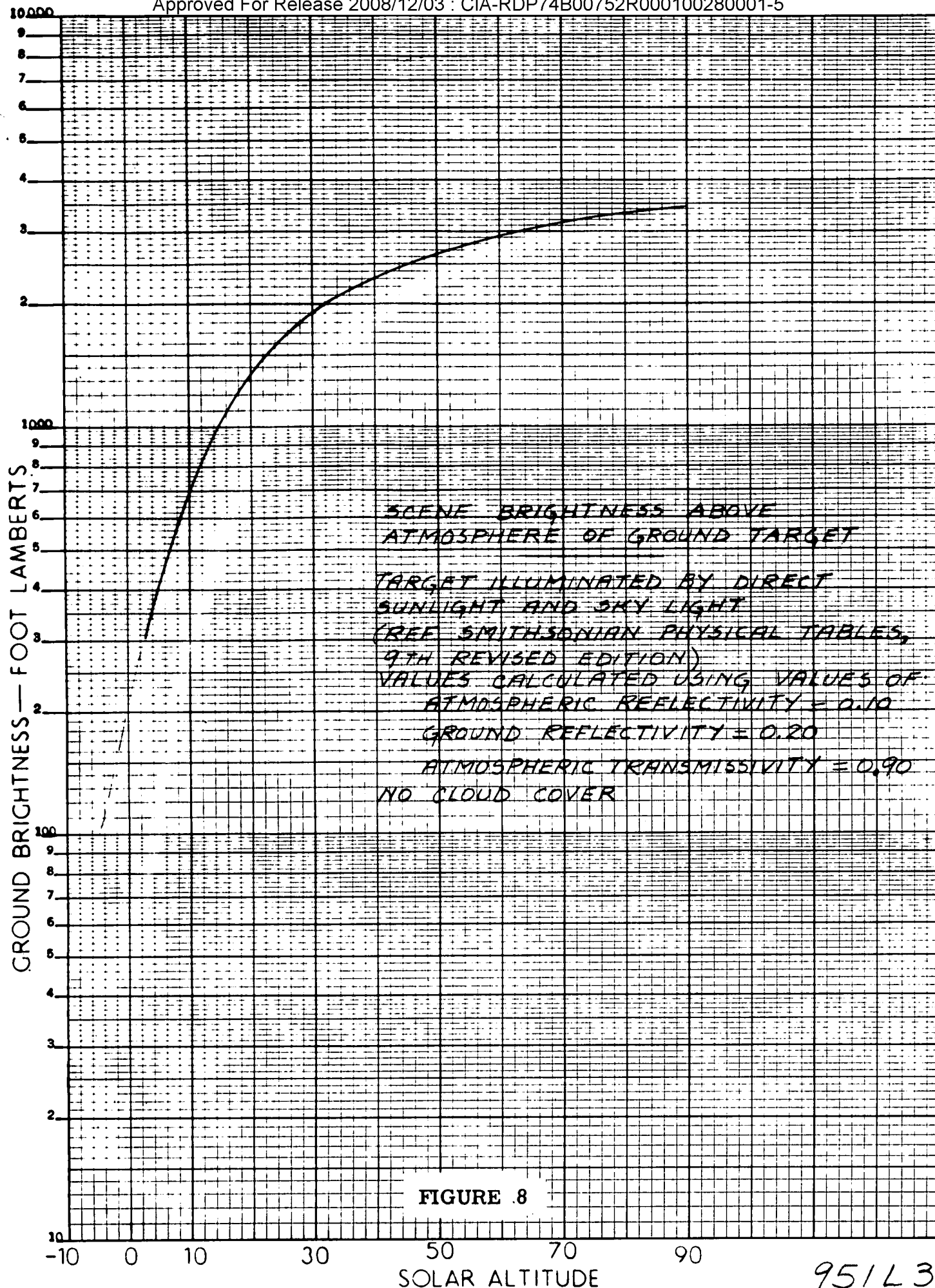


18689

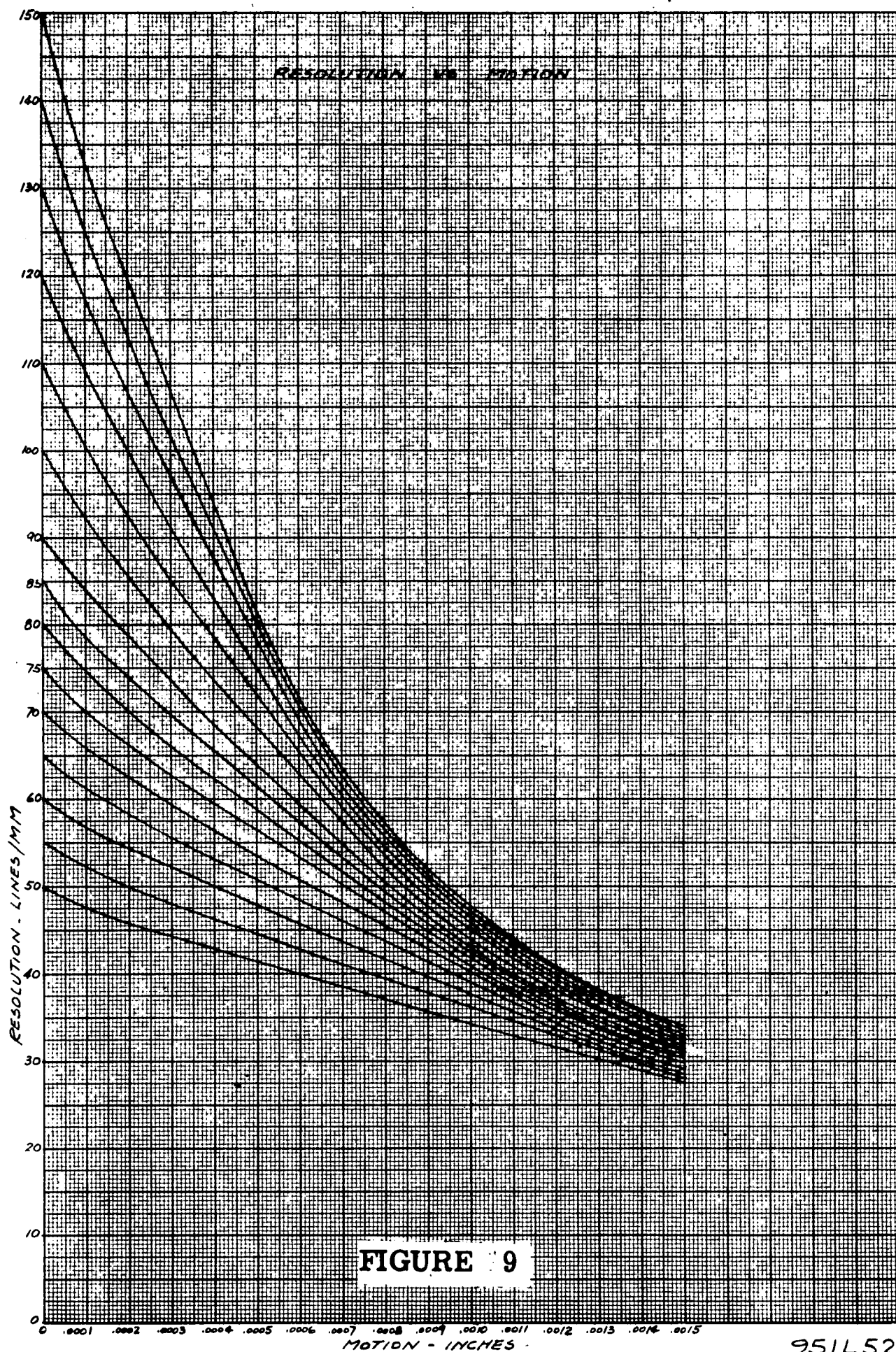


NAME: NODDING MIRROR
 SCALE: 1" = 10" DATE: 1-17-59 DWN: G.L.
 FILM WIDTH: 9 1/2" FORMAT: 9" x 19"
 FOCAL LENGTH: 24 f.5/6
 FILM / CAMERA: 2800' SPOOL DIA: 14"
 WGT. OPTICS:
 WGT. FILM:
 WGT. MECHANISM:
 WGT. MOUNT:
 TOTAL EST. WGT. / CAMERA:
 EST. WGT. CAMERA SYSTEM:
 WINDOW SIZE: 12" x 25" (2)

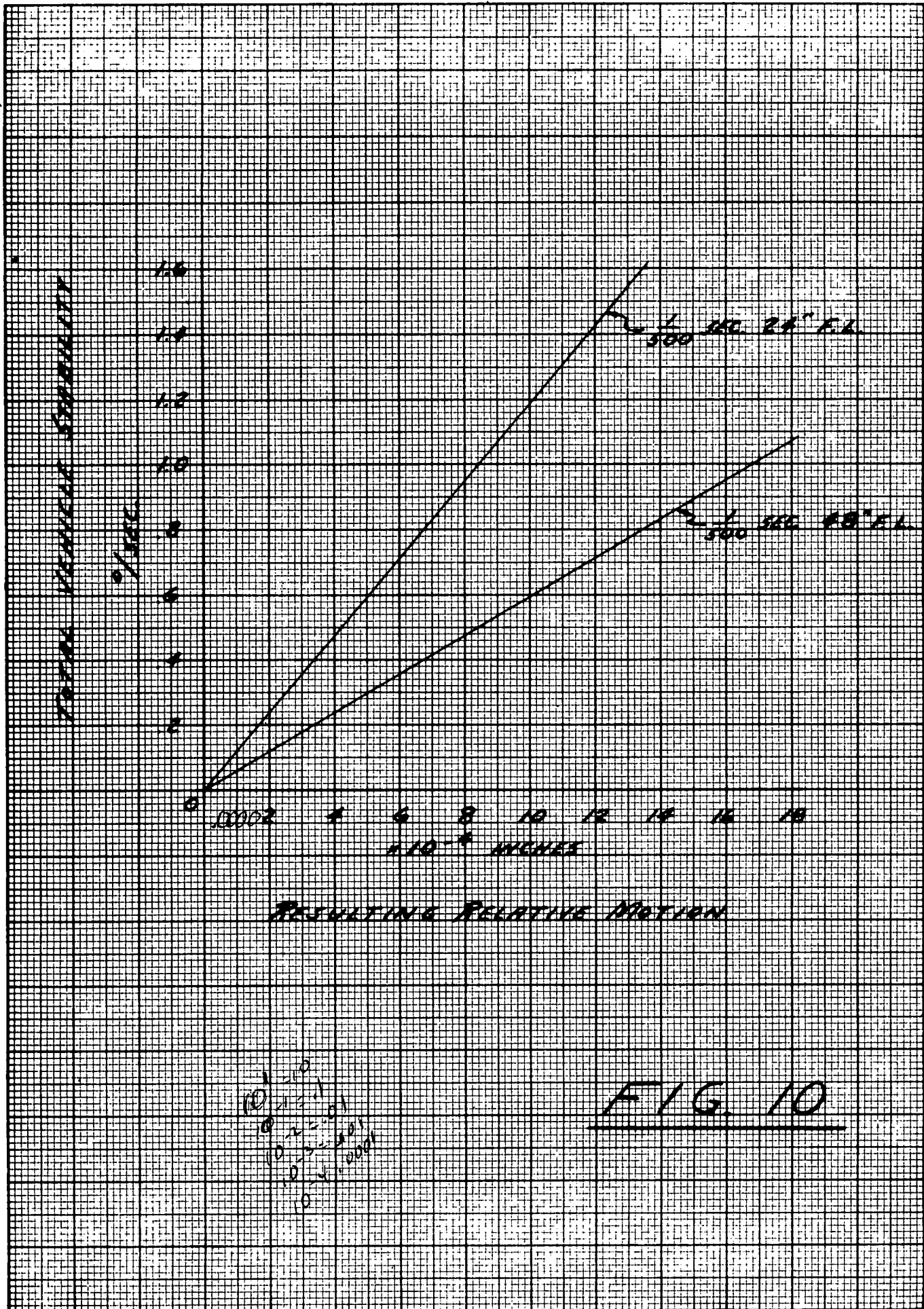


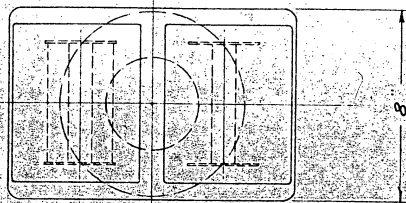


951L39



951L52



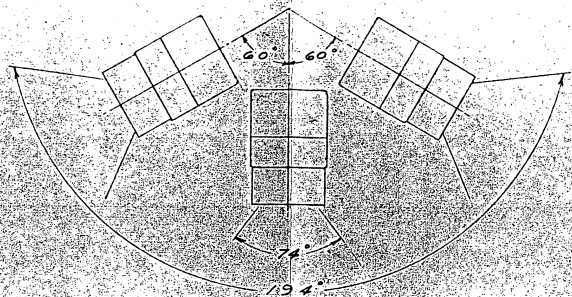
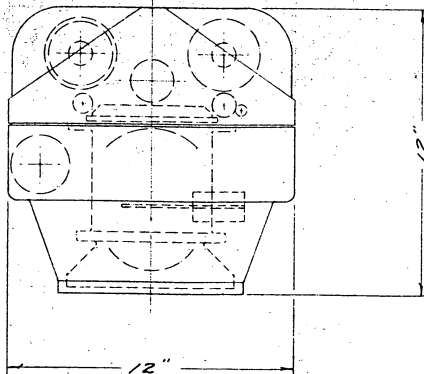


3" 3.5 BAKER MAPPING LENS

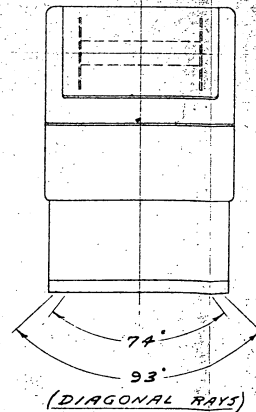
100 - 700 SEC. SHUTTER TIME

4 1/2 x 4 1/2" FORMAT

200 FT. of 5" FILM



TRI-NET INSTALLATION



INDEX MAPPING CAMERA

FIG. 11